

Supporting Information
for

“An Examination of Nanoparticle Filtration by Filtering Facepiece Respirators During the COVID-19 Pandemic”,

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I. Active Layer and All Layer Comparison

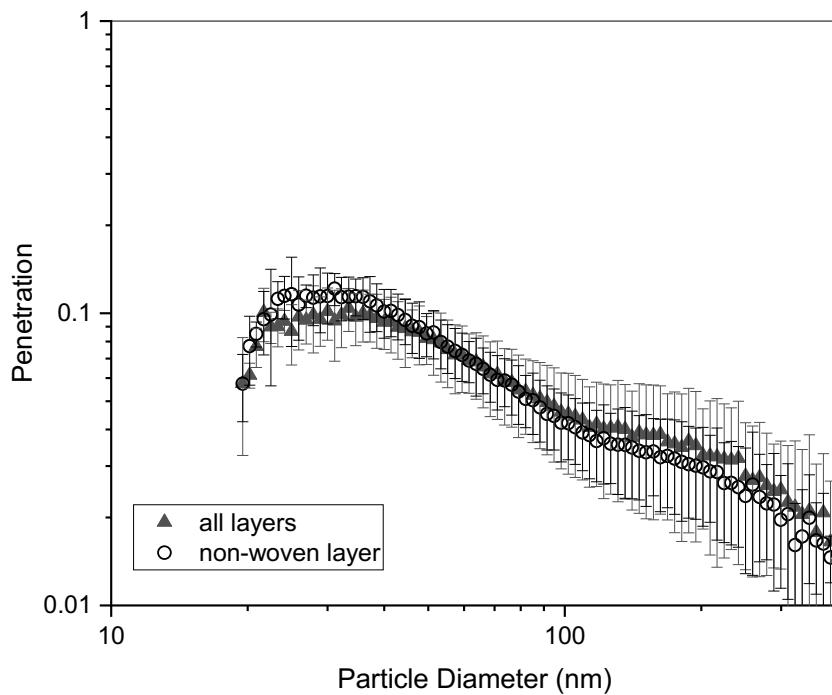


Figure S1. Penetration fraction of Respirator 8 with all layers and non-woven layer

II. Additional IPA Treatment Results

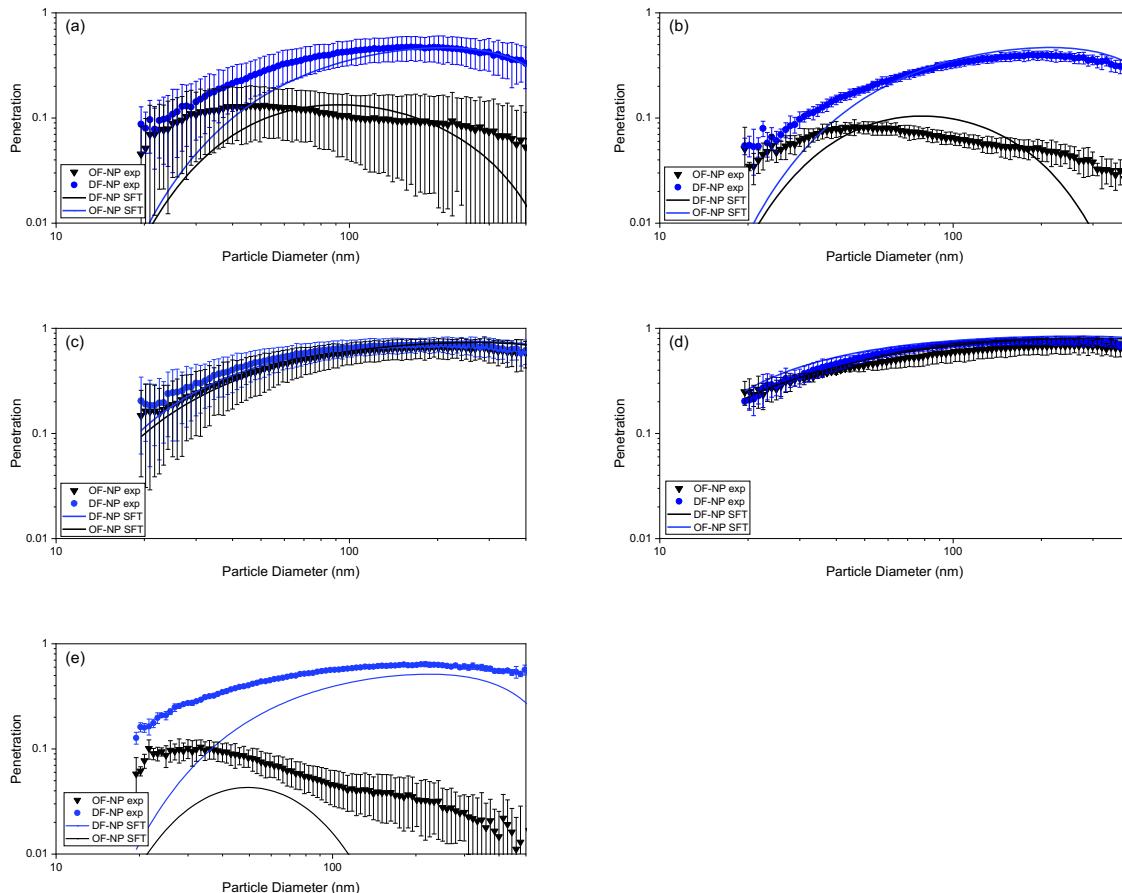


Figure S2. Experimental result and single fiber theory calculation of aerosol penetration vs. particle diameter for the original (OF) and the IPA-treated (DF) samples challenged with neutralized aerosols (NP): (a) Respirator 4, (b) Respirator 5, (c) Respirator 6, (d) Respirator 7, and (e) Respirator 8.

Table S1. Filter properties of Respirators 4 through 8

Sample ID	Thickness (μm)		Basis weight (g/m ²)		Fiber diameter (μm)	Estimated charge density (μC/m ²)
Layer(s)	All	Active	All	Active	Active	Active
Respirator 4	673 ± 28	519 ± 77	250	62	4.29 ± 2.49	8.01
Respirator 5	464 ± 27	453 ± 13	181	63	4.25 ± 2.34	12.42

Respirator 6	467 ± 89	382 ± 113	175	56	6.41 ± 4.68	0.07
Respirator 7	527 ± 38	246 ± 23	163	27	5.36 ± 3.96	0.23
Respirator 8	772 ± 43	459 ± 55	194	70	4.08 ± 2.63	28.28

Table S2. Filtration performances of the original (OF-NP) and IPA-treated (DF-NP) Respirators 4 through 8

Sample ID		OF-NP	DF-NP
Respirator 4	P	0.11 ± 0.07	0.36 ± 0.11
	ΔP_0 (mmH ₂ O)	20.4 ± 7.4	21.3 ± 7.3
Respirator 5	P	0.07 ± 0.01	0.27 ± 0.03
	ΔP_0 (mmH ₂ O)	20.3 ± 1.4	19.7 ± 3.4
Respirator 6	P	0.50 ± 0.15	0.57 ± 0.13
	ΔP_0 (mmH ₂ O)	11.7 ± 3.8	12.0 ± 4.4
Respirator 7	P	0.53 ± 0.08	0.62 ± 0.06
	ΔP_0 (mmH ₂ O)	8.3 ± 2.2	6.8 ± 1.2
Respirator 8	P	0.06 ± 0.02	0.49 ± 0.01
	ΔP_0 (mmH ₂ O)	10.8 ± 1.5	10.0 ± 0.8

III. Additional Information for Single-Fiber Efficiency Calculations

$$Ku = -\frac{\ln \alpha}{2} - \frac{3}{4} + \alpha - \frac{\alpha^2}{4} \quad \text{Eq. S1}$$

$$Stk = \frac{\rho_p d_p^2 Cv}{18 \mu d_f} \quad \text{Eq. S2}$$

$$J = \begin{cases} (29.6 - 28\alpha^{0.62})R^2 - 27.5R^{2.8} & (R < 0.4) \\ 2 & (R \geq 0.4) \end{cases} \quad \text{Eq. S3}$$

$$D = \frac{kTC}{3\pi\mu d_p} \quad \text{Eq. S4}$$

$$Pe = \frac{d_f v}{D} \quad \text{Eq. S5}$$

$$R = \frac{d_p}{d_f} \quad \text{Eq. S6}$$

$$C = 1 + \frac{2\lambda}{d_p} (1.257 + 0.4 \exp(-\frac{1.1d_p}{\lambda})) \quad \text{Eq. S7}$$

Ku is the Kuwabara number. Stk is the Stokes number. D is diffusivity. T is temperature. k is the Boltzmann constant. α is filter solidity. Pe is the Peclet number. μ is air viscosity, λ is the mean-free path for air, and v is the face velocity of filtration. ρ_p is the particle density. C is the Cunningham correction factor. d_p and d_f stand for the particle and fiber diameters, respectively.

Table S3. Parameter values used in the Single Fiber Theory calculation*

Parameter	Value	Unit
v	0.096	m/s
μ	1.8E-5	kg/m-s
λ	6.6E-8	m
k	1.38E-23	$\text{m}^2\text{kg/s}^2\text{-K}$
T	293	K
ρ_p	2160	kg/m ³
ε_0	8.86E-12	C ² /N-m ²
ε_p	5.9 ³⁸	-
ε_f	2.3 ³⁹	-

* Filter properties, including thickness, basis weight, and fiber diameter, are listed in Table 1 and Table S1.

IV. Penetration versus Basis Weight and Thickness

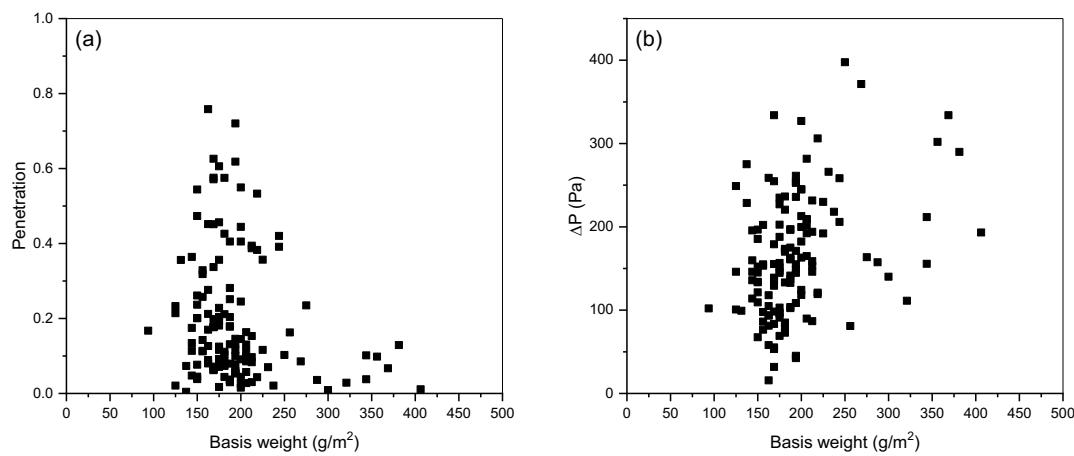


Figure S3. (a) Total penetration and (b) pressure drop of the 136 samples vs. basis weight.

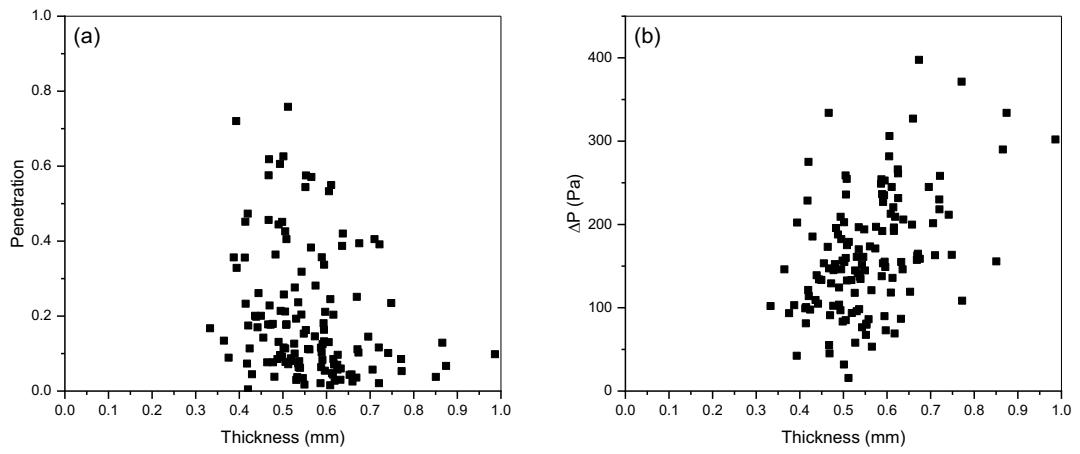


Figure S4. (a) Total penetration and (b) pressure drop of the 136 samples vs. respirator thickness (including all layers).